Geomorphic Components of Riparian Ecosystems

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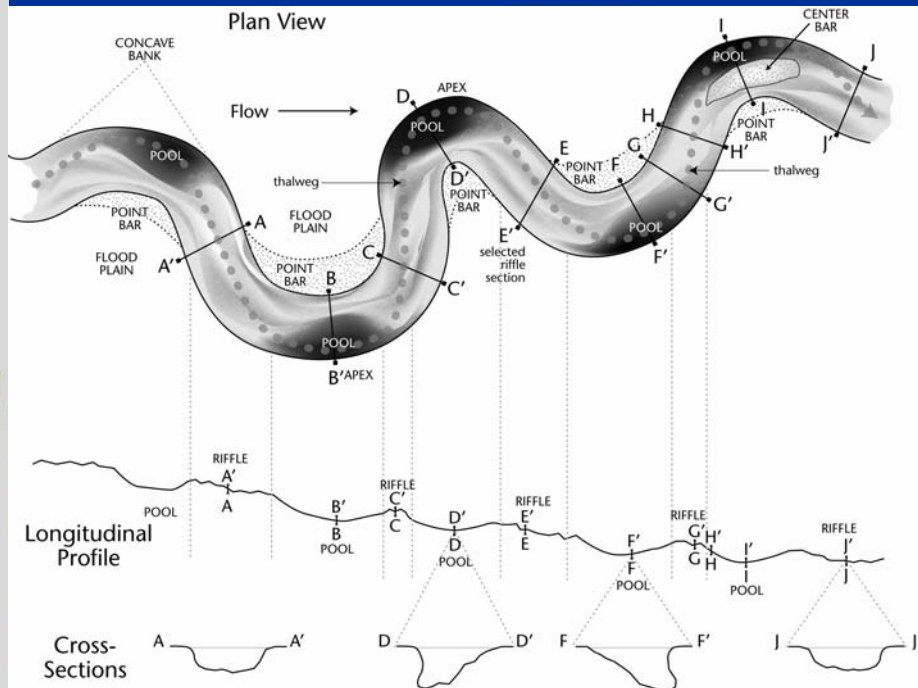

Fluvial Geomorphology

Review and Terminology

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United States Department of Agriculture

NRCS Natural Resources Conservation Service

USDA

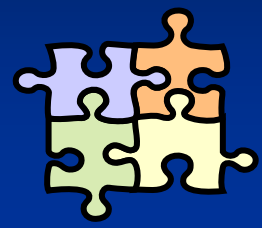
What is Fluvial Geomorphology?

- Fluvial Geomorphology is the study of earth surface forms and processes in a riverine system.
- In simpler terms, it is the study of natural channels and the processes that form them. (i.e. floodplains, stream channel dimensions, sinuosity and so forth.)
- Fluvial Geomorphology is both quantitative and qualitative depending on the study, but observation without validation is not complete.

Eight Physical Variables Governing Stream Form and Function

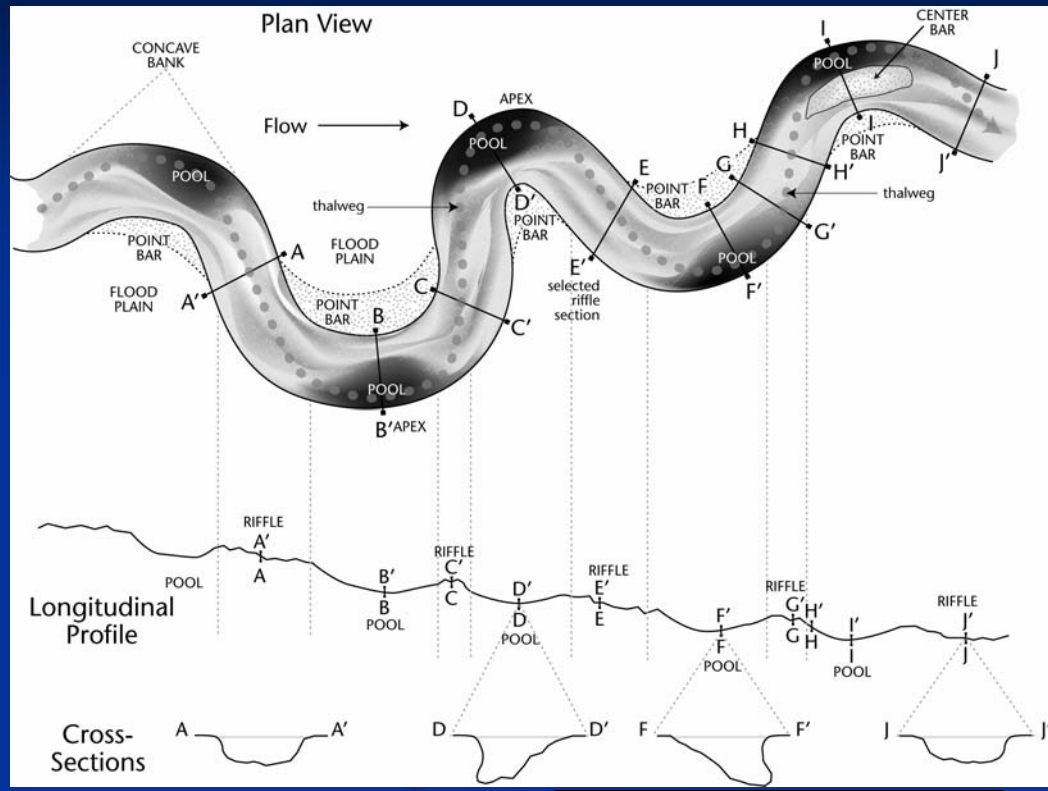
- Width
- Depth
- Velocity
- Discharge
- Slope
- Roughness
- Sediment Size
- Sediment Concentration

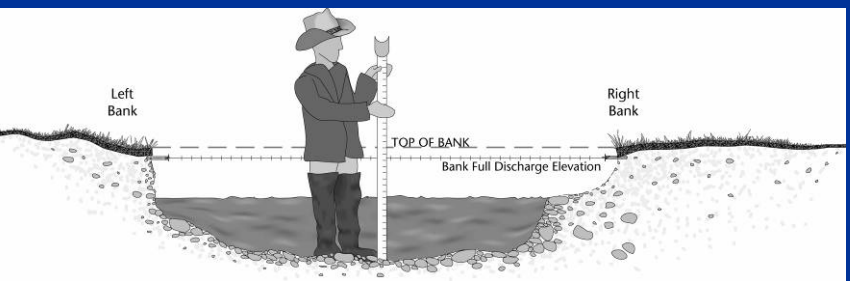
Understand how vegetation affects these and you can understand threshold and transition.



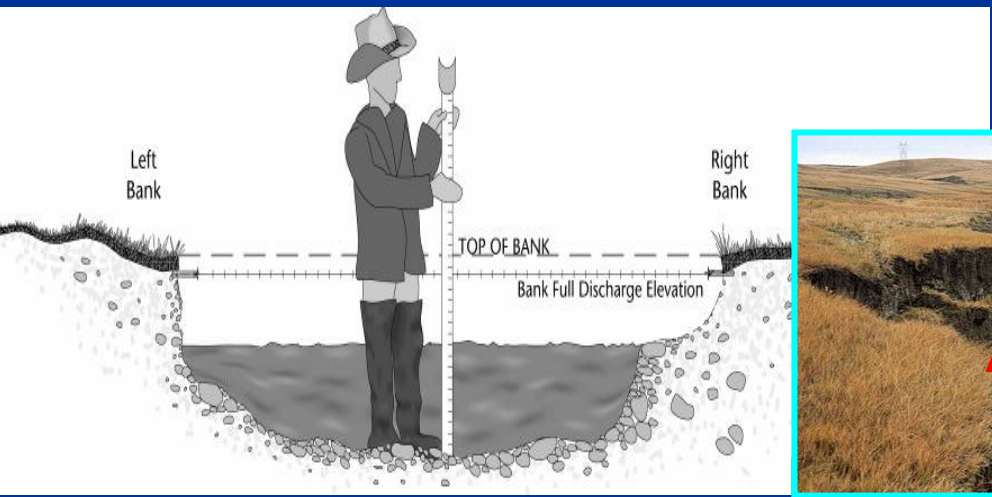
Stream Morphometry

Stream morphometry is the measurement of physical dimensions of a (fluvial) object. This is what you do when you take measurements with a tool and apply them to define a dimension.





So we often use stream morphometry to get at an accurate representation morphology, but more importantly, an accurate characterization of stream morphology.



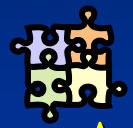
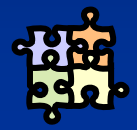
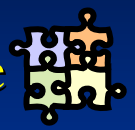
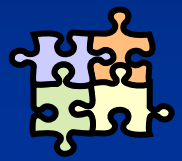
4 streams

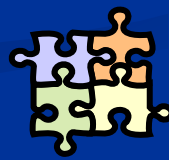
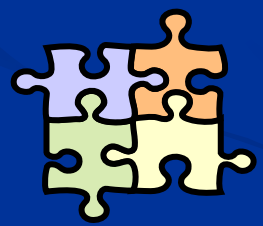
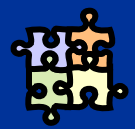
4 different stream types

4 distinctly different kinds of potential

Geomorphic Terms (Physical Measures Potentially Useful to Riparian ESD

- Width to depth ratio
- Particle size distribution, e.g. d_{50}
- Sinuosity
- Floodprone Area
- Hydraulic geometry
- Channel Evolutionary Stage (Schumm)
- Hydrophysiographic Region (Area)
- Geomorphic Reference site (current stable analog vs. historical analog
- Channel incision and bank height ratio
- Meander belt width
- Meander width ratio
- Dimension, Pattern, and longitudinal profile
- Streambank Stratigraphy
- Geomorphic Valley Type GIS Potential for ESDs
- Channel Stage of Adjustment

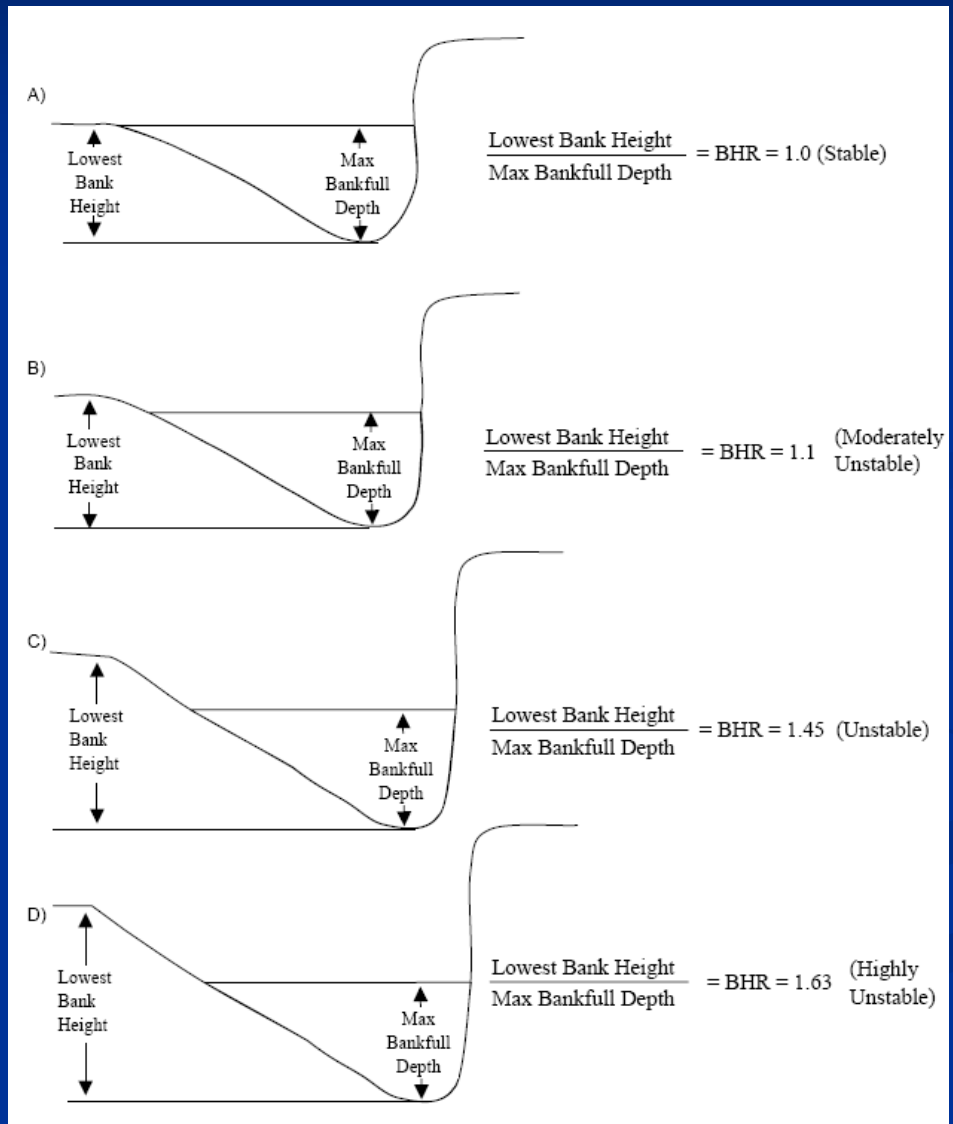




Well developed floodplain re-established at lower elevation

Stage V

Pataha Creek, WA

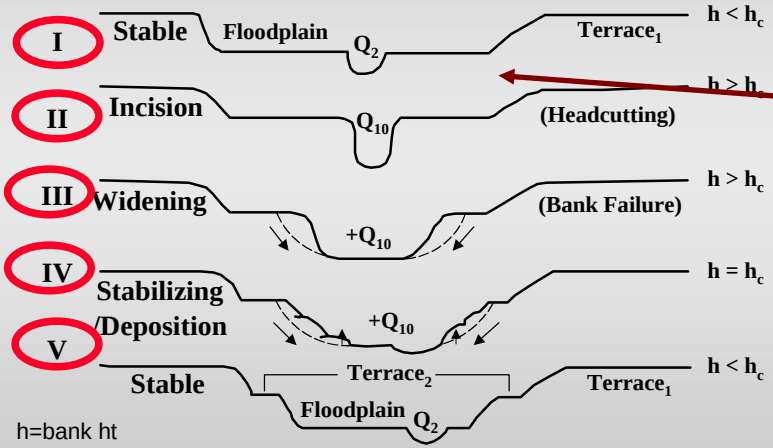
Bank Height Ratio Measure Relative to Floodplain Connectivity



Channel Evolution Model and BHR

Channel Evolution Models

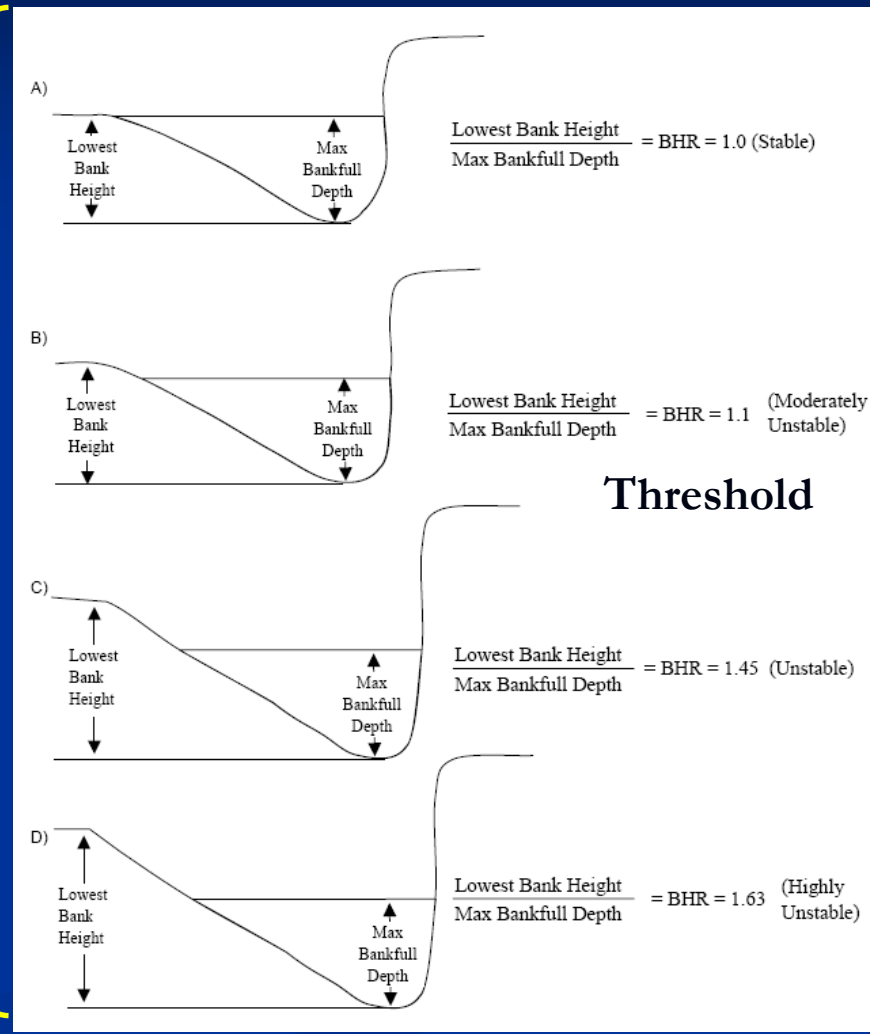
Schumm, Harvey, Watson (1984):



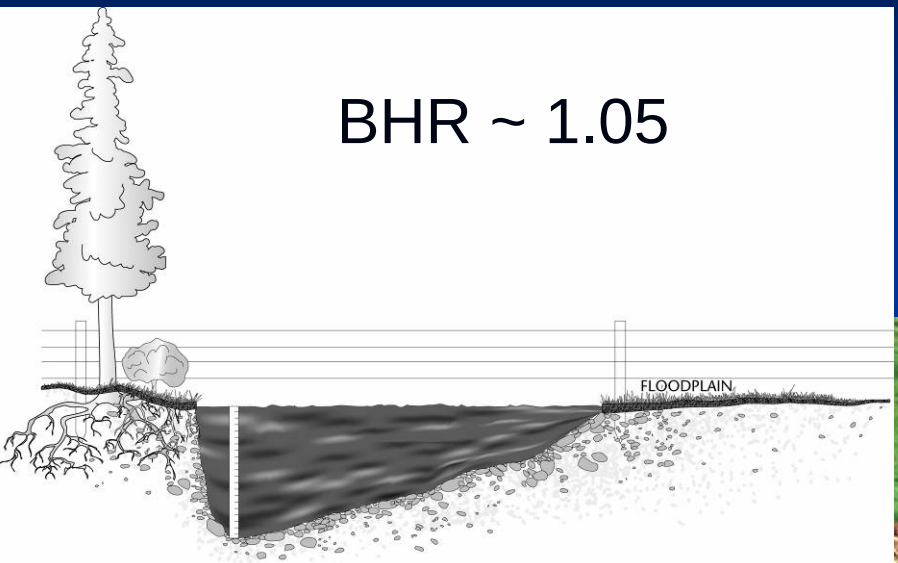
h=bank ht

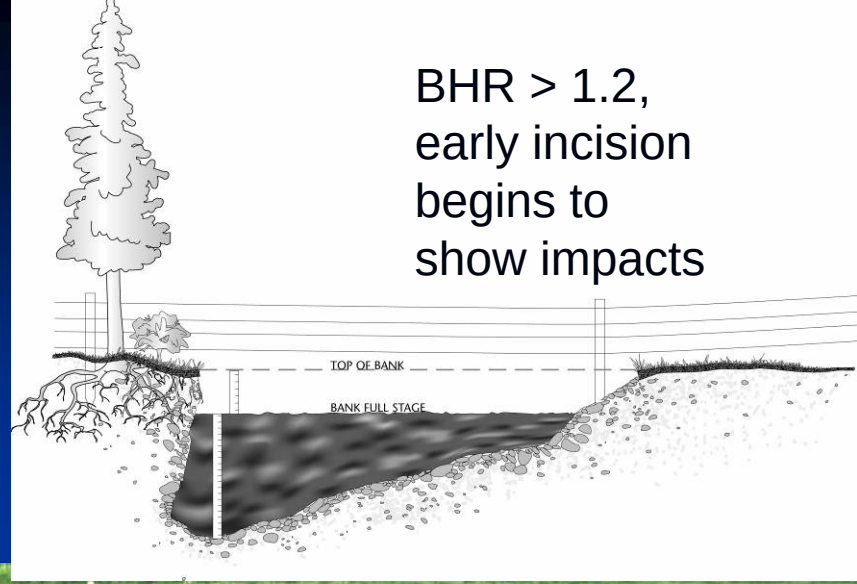
hc=critical bank ht.

Slide modified from Lyle Steffen

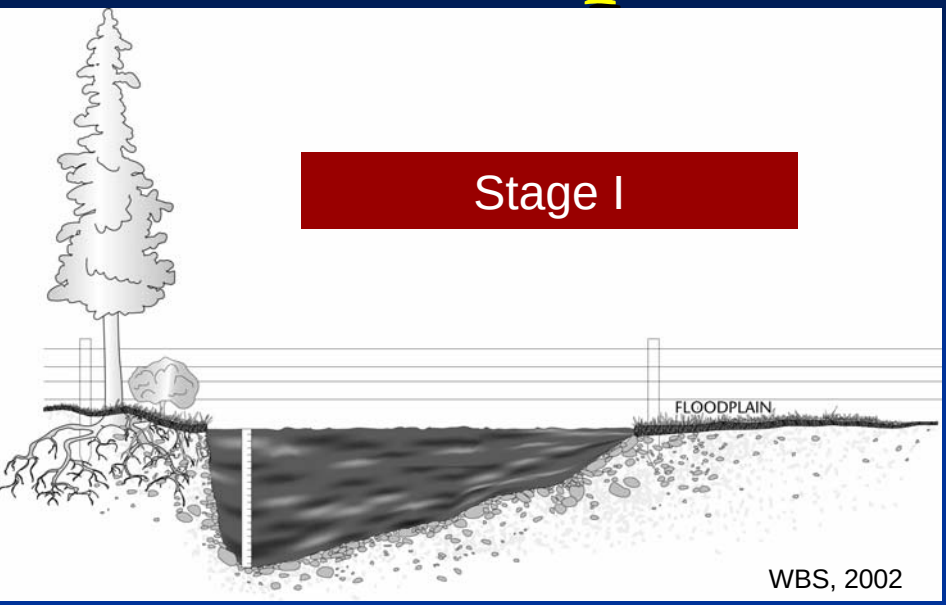


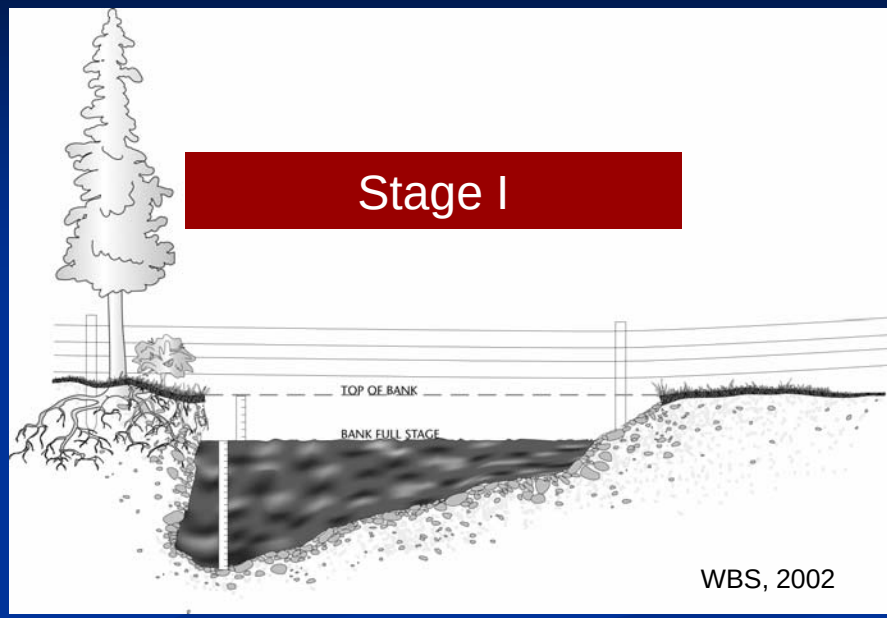
Why Bank Height ratio (BHR)?



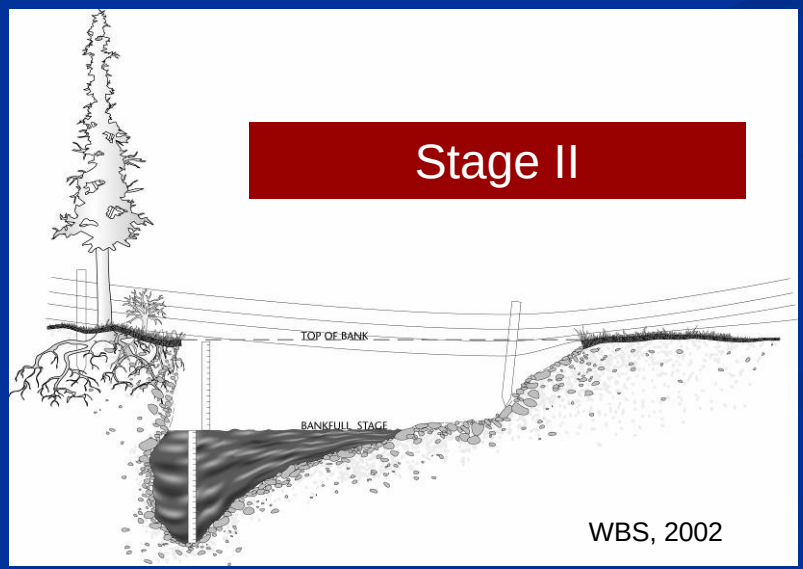


Floodplain Abandonment





Schumm Channel Evolution Model and Bank Height Ratio (BHR)



BHR = Top of the Bank / Bankfull Height. This is a measure of the degree of incision

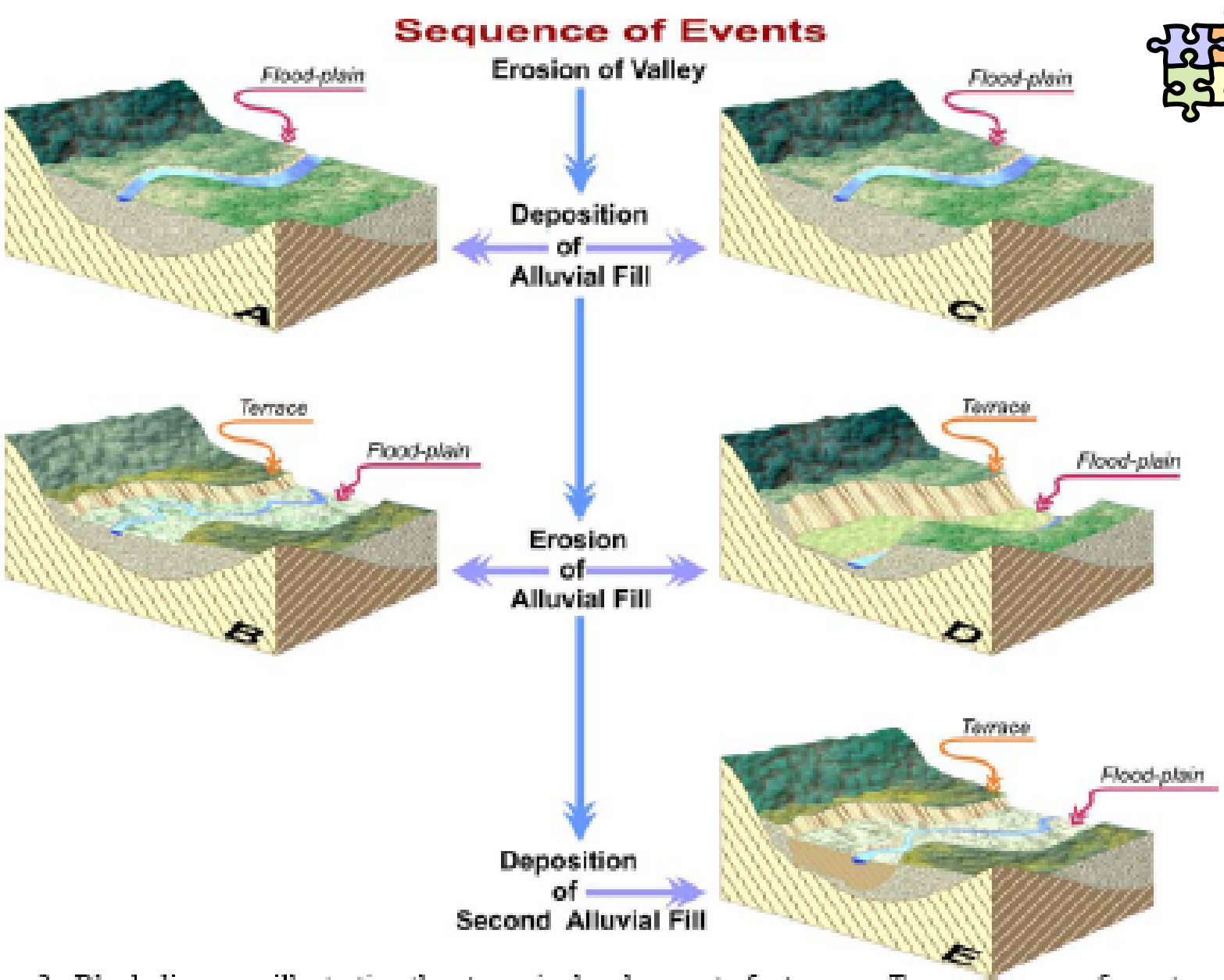


Figure 3. Block diagrams illustrating the stages in development of a terrace. Two sequences of events leading to the same surface geometry are shown in diagrams A, B, and C, D, E respectively (Leopold et al, 1964).

Tributary to Rapid Creek west of Rapid City, SD

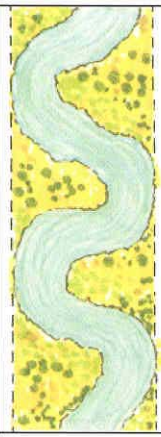
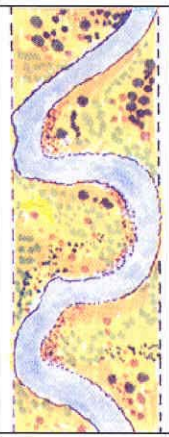
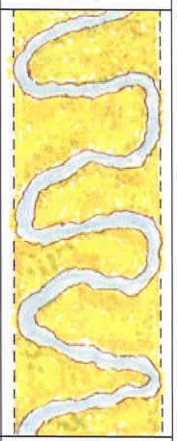
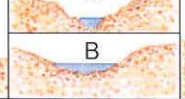
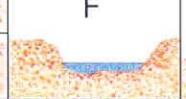
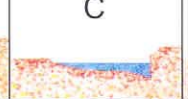
Rio de la Vaca, near Cuba, New Mexico

- What is the most significant difference between a Stage I and Stage V ?
- Answer – Floodplain Confinement, Morphometry – Meander Width Ratio

Degree of channel confinement-lateral containment is: Meander Width Ratio

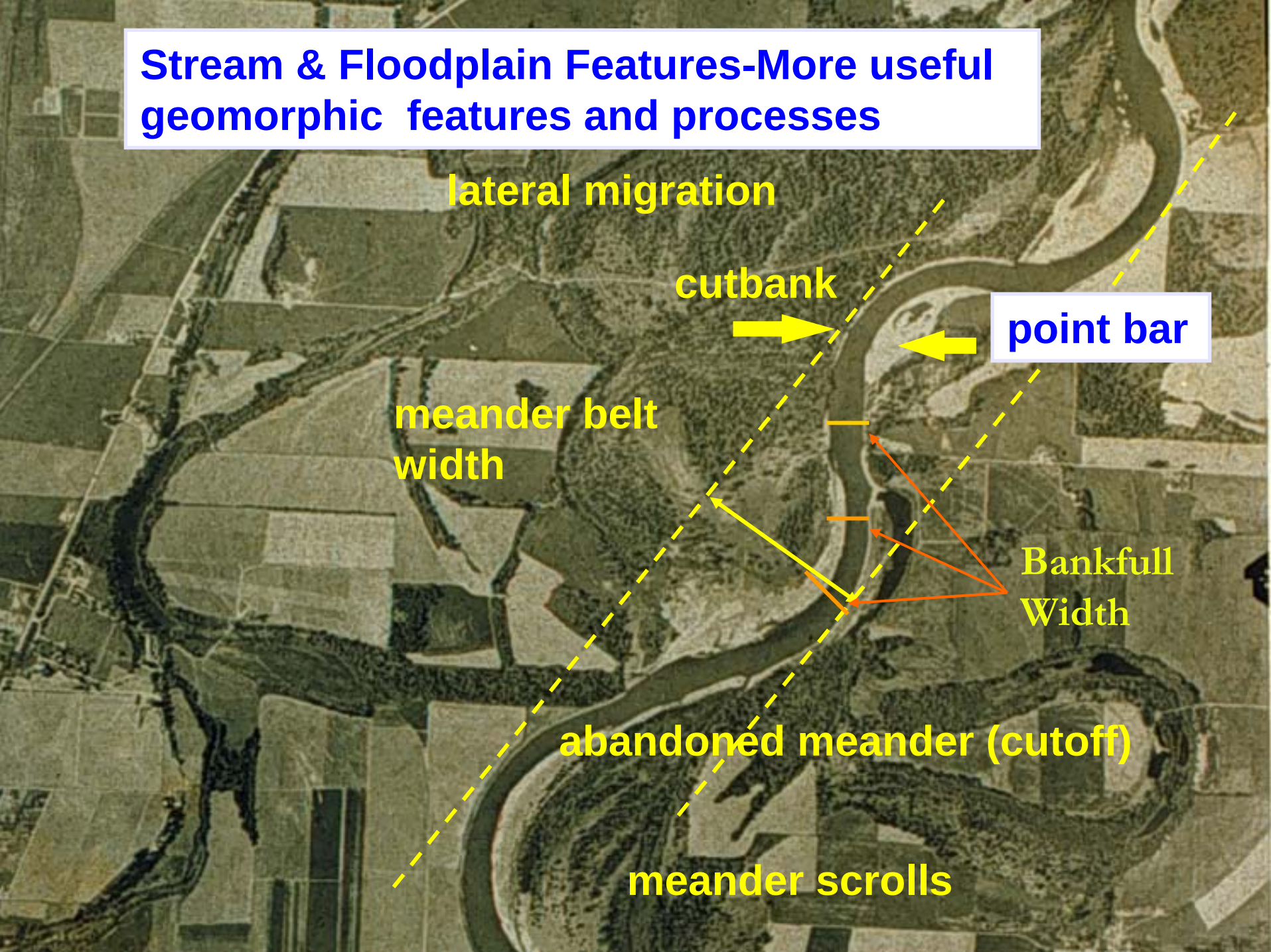
Channel encroachment can limit the lateral containment of rivers. This perturbation can cause negative adjustments to dimension, pattern, and profile outside of the range of natural variability for the stream type

Meander Width Ratio (MWR) by Stream Type Categories

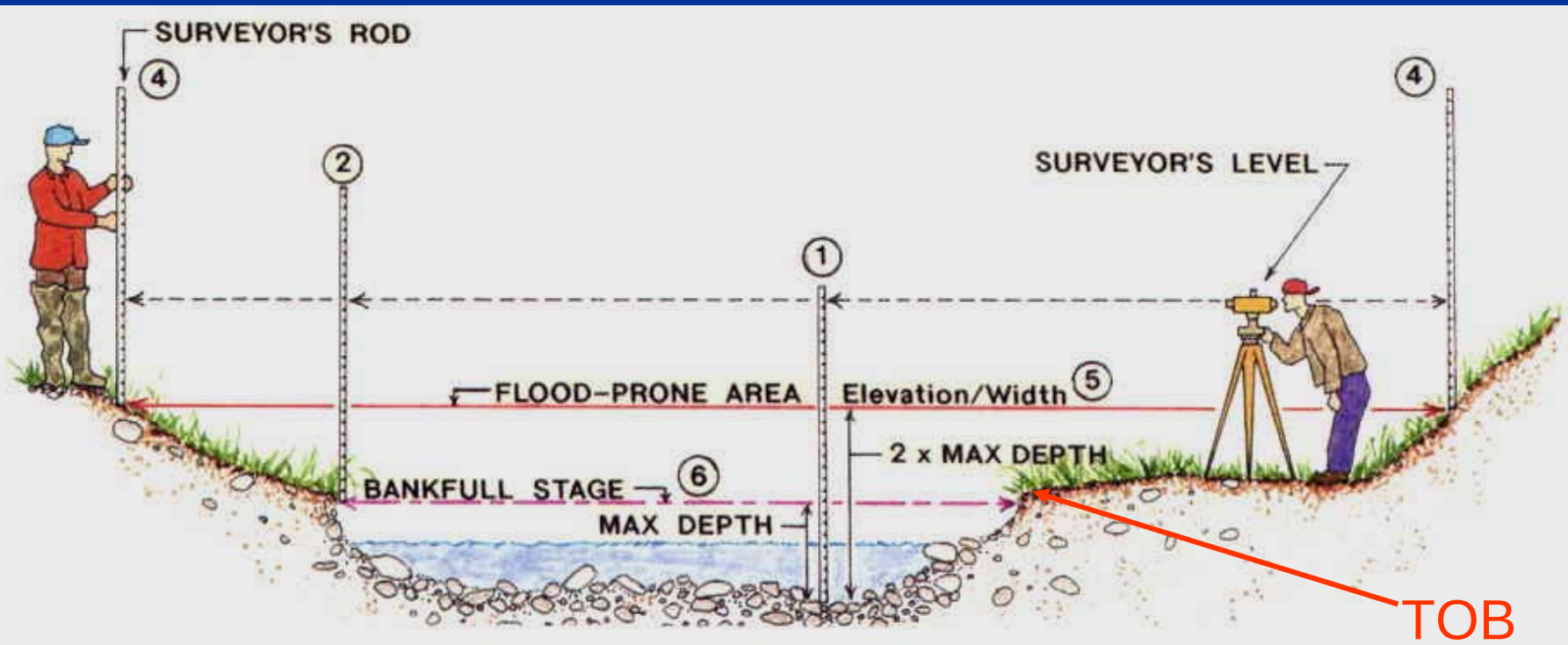
STREAM TYPE	A	D	B & G	F	C	E
PLAN-VIEW						
CROSS-SECTION VIEW						
AVERAGE VALUES	1.5	1.1	3.7	5.3	11.4	24.2
RANGE	1 - 3	1 - 2	2 - 8	2 - 10	4 - 20	20 - 40

MWR = Belt width/bankfull discharge width

Belt width is the farthest lateral extent measured from the outside bend to outside bend


Stream & Floodplain Features-More useful geomorphic features and processes
lateral migration
cutbank
point bar
meander belt width
Bankfull Width
abandoned meander (cutoff)
meander scrolls

Floodprone Determination (Degree of Entrenchment) The degree of entrenchment ratio is a measure of the lateral floodplain development



Determining Floodprone Width

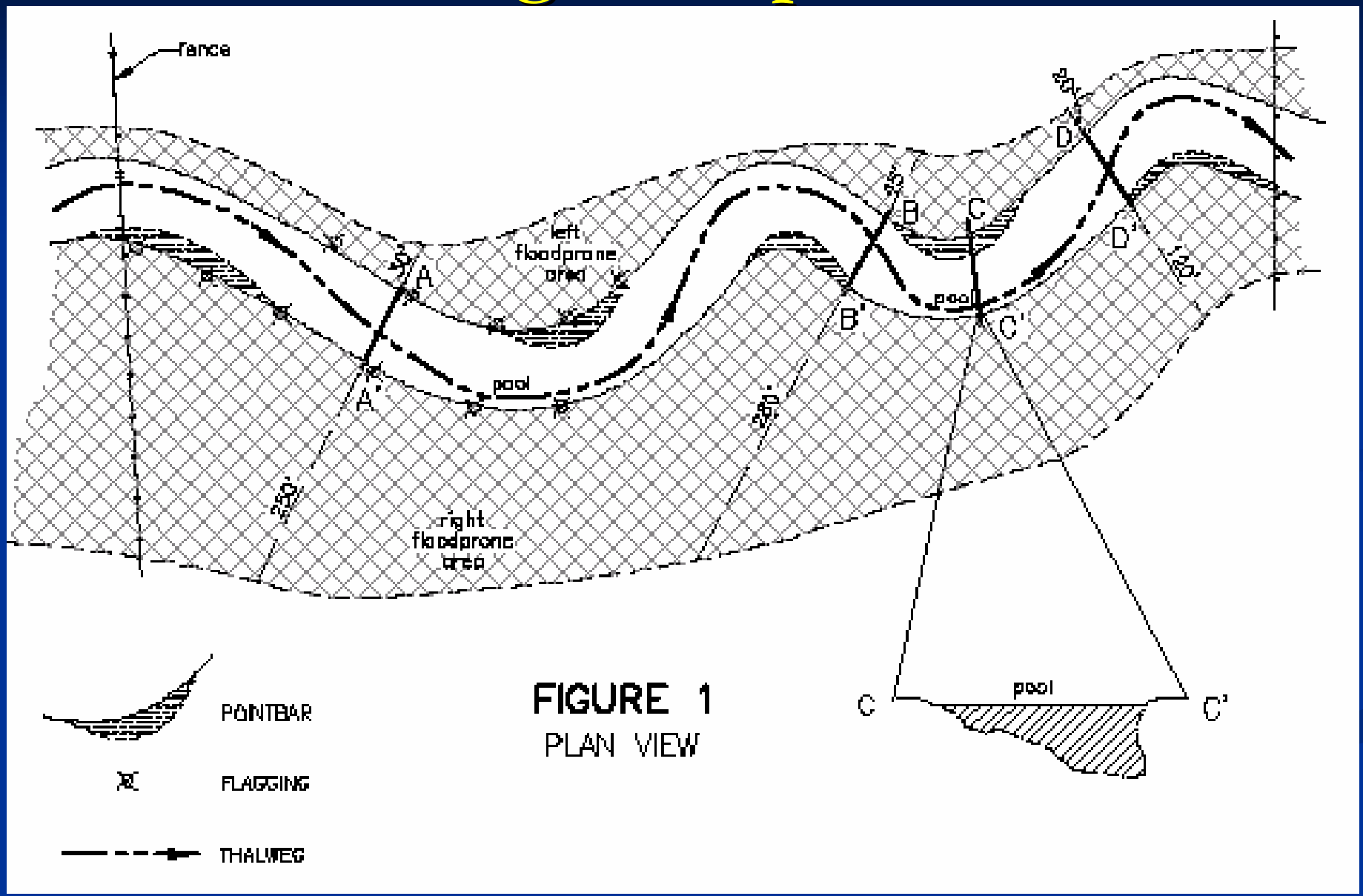


FIGURE 1
PLAN VIEW

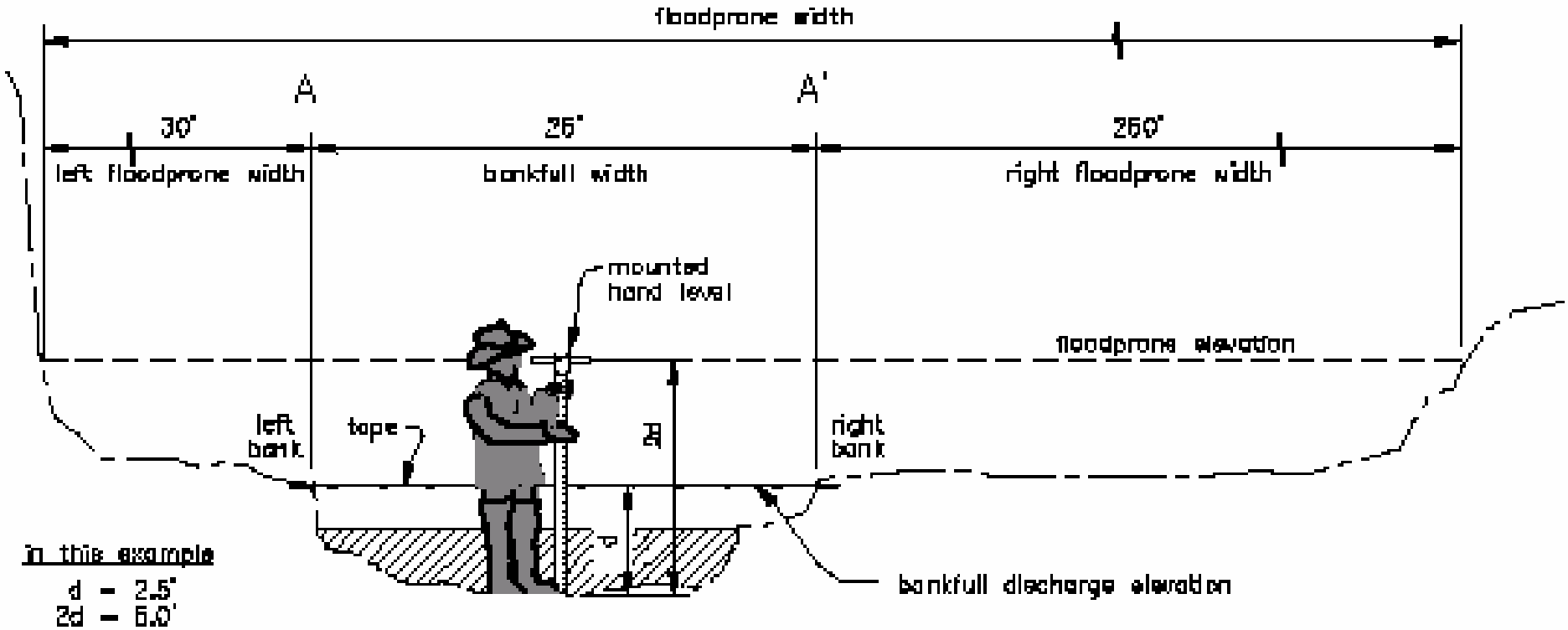
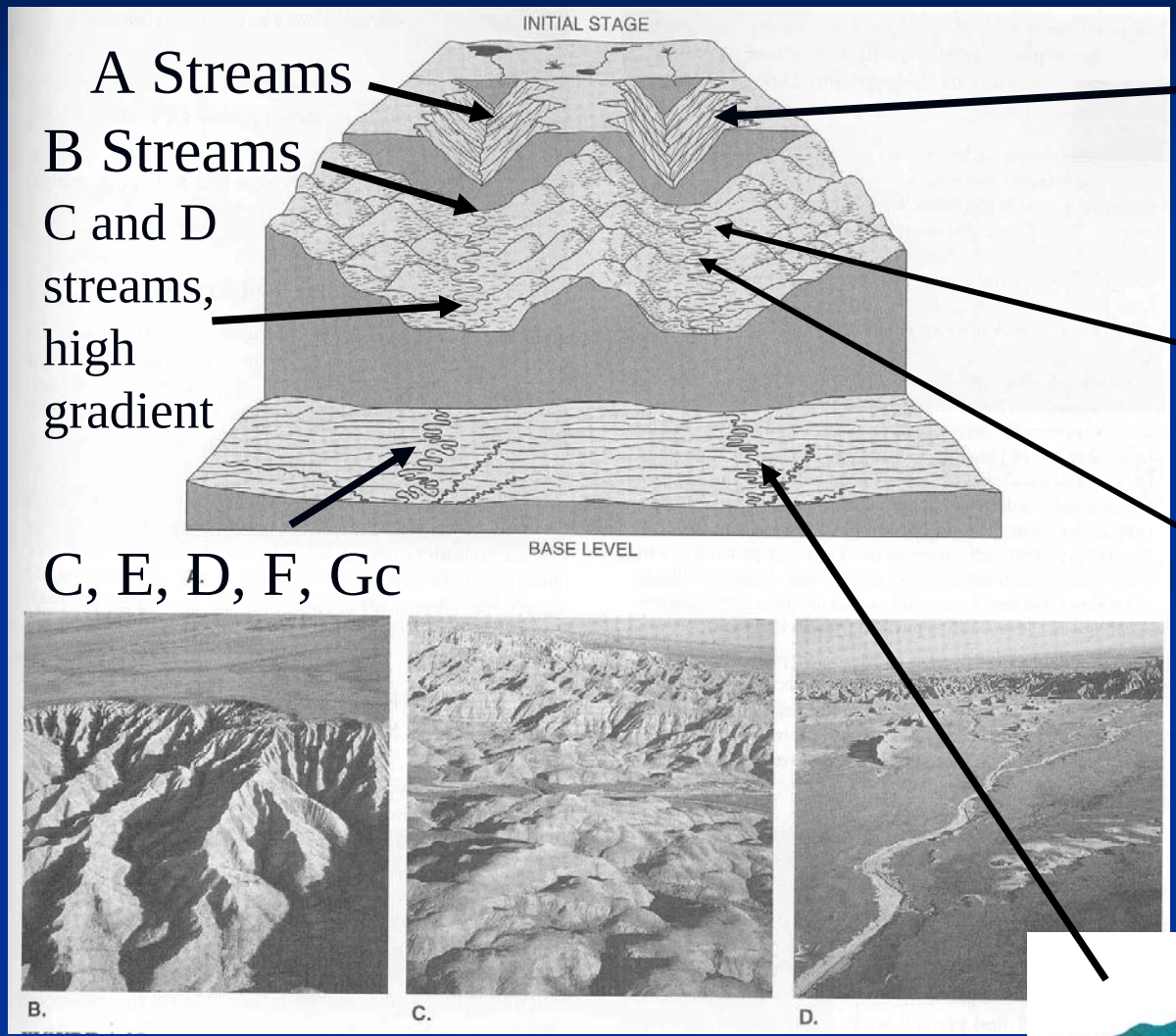


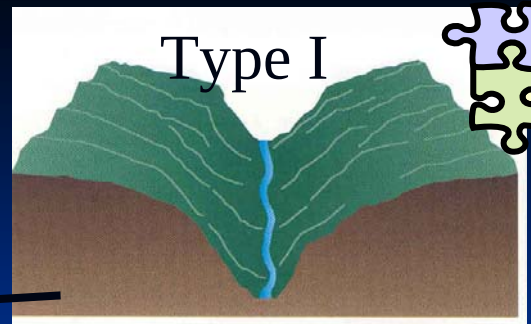
FIGURE 2

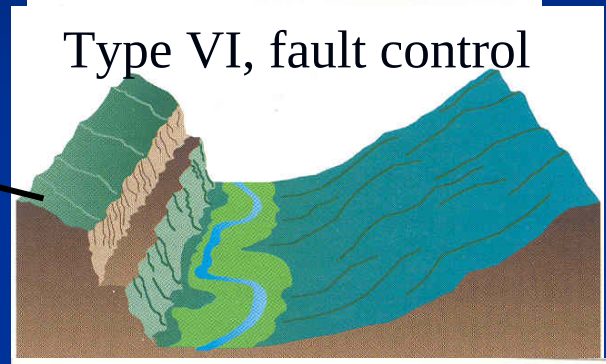
CROSS-SECTIONS

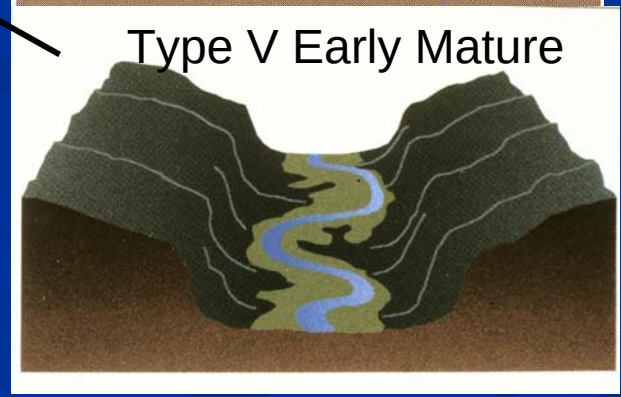
FIGURES ARE NOT TO SCALE

Valley Types and Stream Classification

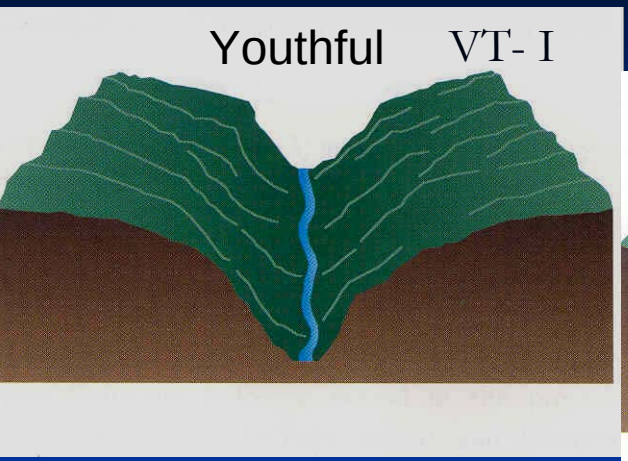




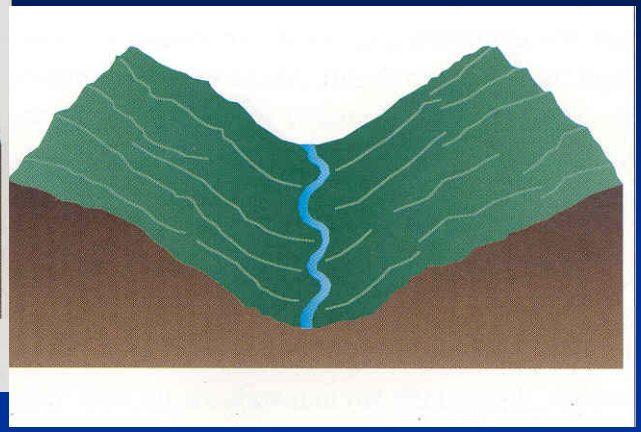


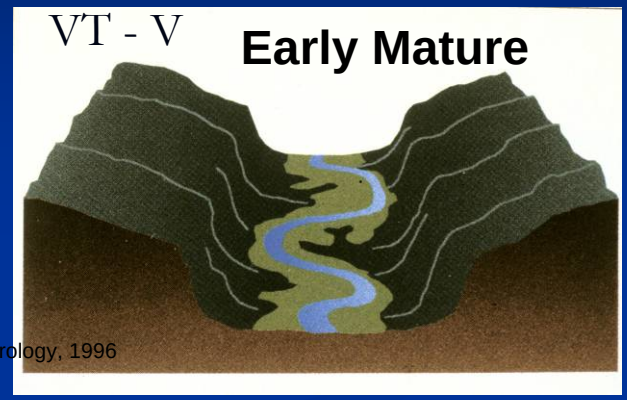


Geomorphic Valley Types

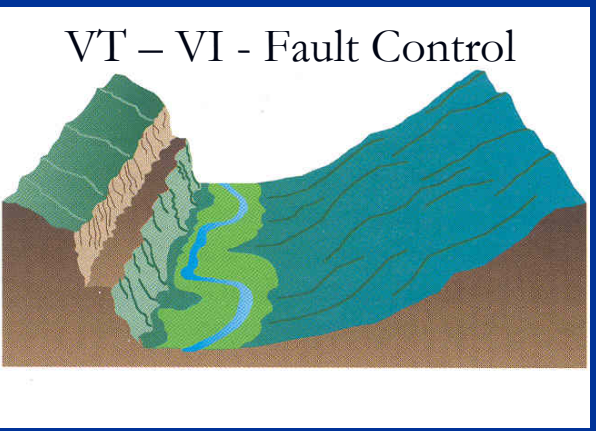


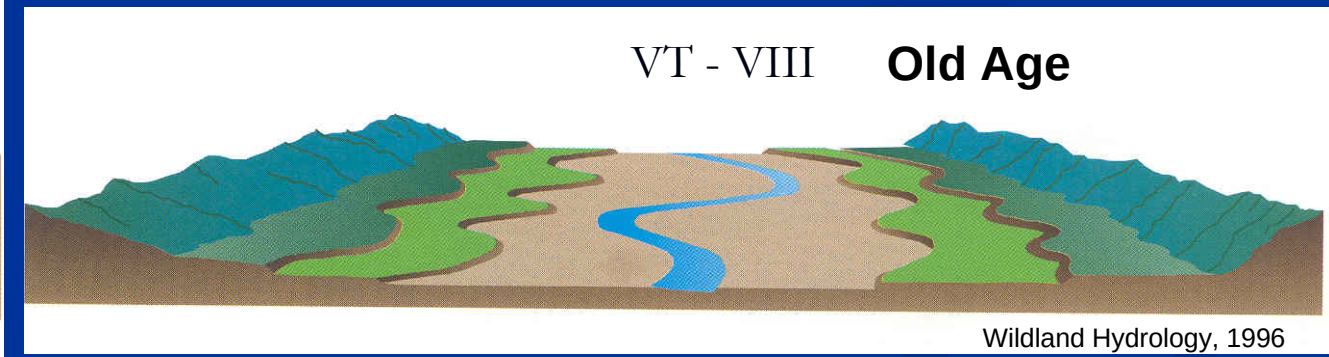
Wildland Hydrology, 1996





Wildland Hydrology, 1996



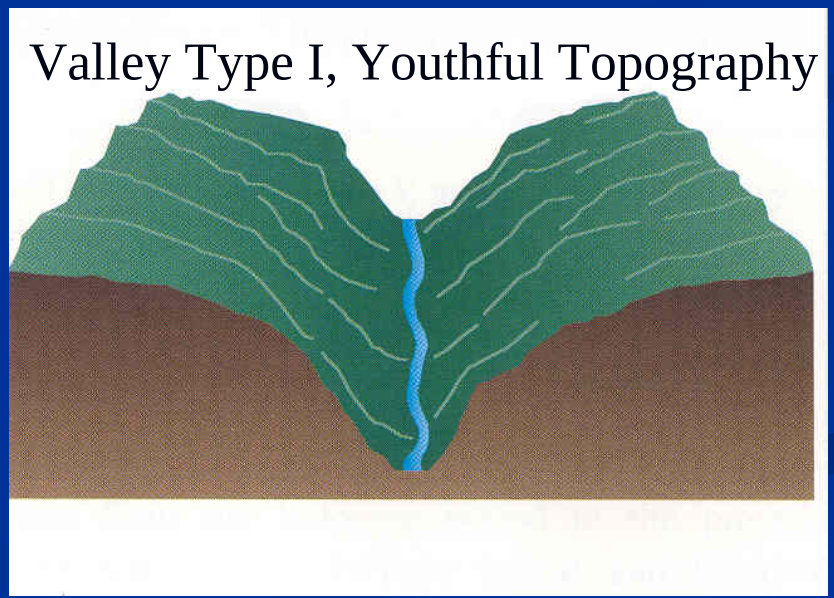


Wildland Hydrology, 1996

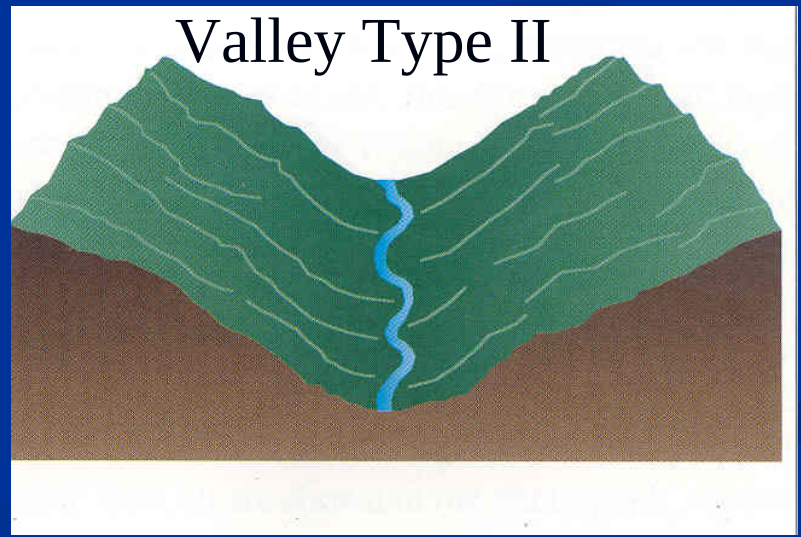
Wildland Hydrology, 1996

A1a Morphology

A1a Trib. to Uncampaghre



B stream Type in Valley Type II Young Valleys

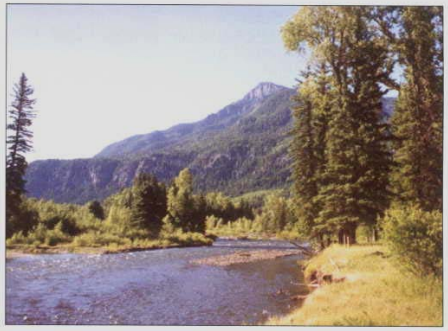


Valley Type V – Glacio-fluvial trough

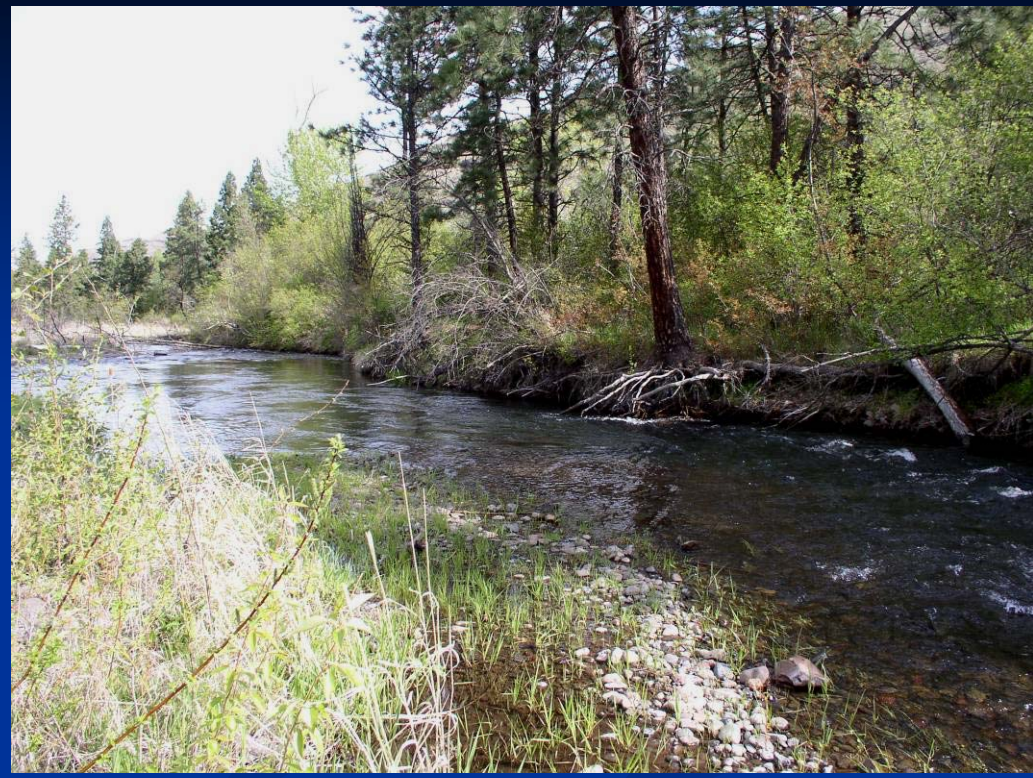
THE MORPHOLOGICAL DESCRIPTION

C4 - New Mexico

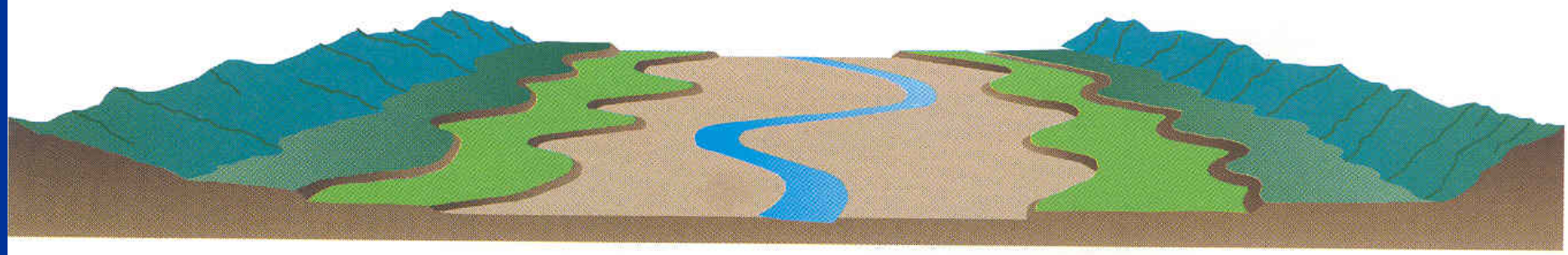
C4 - Colorado



C4 - Wisconsin

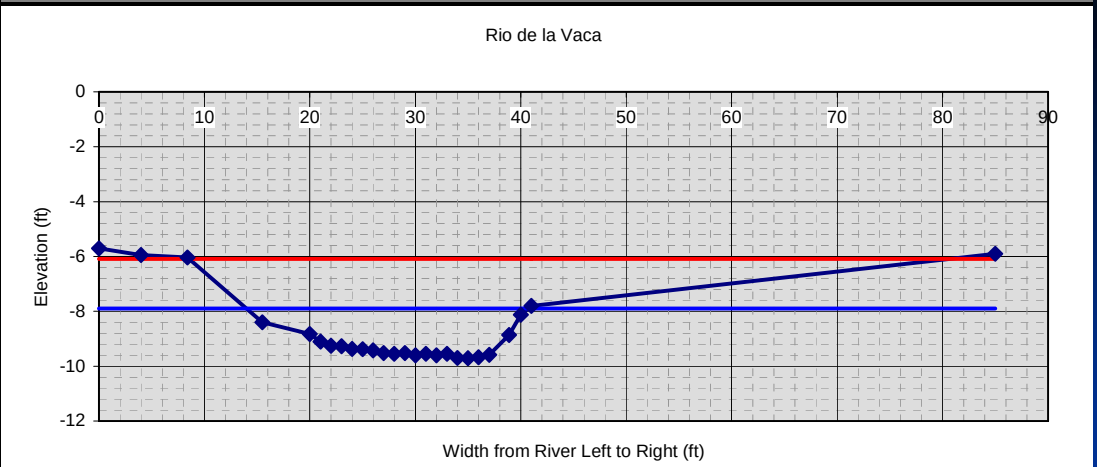


Valley Type VIII multiple holocene terraces



Valley Type X: Often E or C
Lacustrine (lake formed) – very flat

Cross Section



section:	BFQ 4 at elevations 7.8 to 7.9 was the cont. dep. feature relative to regional
	Riffle

	---
description:	Rio de la Vacas - Cannot use this Manning's n for bfq discharge. 61 mm not the
height of instrument (ft):	

notes	omit pt.	distance (ft)	FS (ft)	elevation
	# ✓ #			
	# ☐ #	0	5.71	-5.71
	# ☐ #	4	5.95	-5.95
	# ☐ #	8.4	6.04	-6.04
	# ☐ #	15.5	8.4	-8.4
	# ☐ #	20	8.83	-8.83
	# ☐ #	21	9.1	-9.1
	# ☐ #	22	9.25	-9.25
	# ☐ #	23	9.27	-9.27
	# ☐ #	24	9.37	-9.37
	# ☐ #	25	9.38	-9.38
	# ☐ #	26	9.42	-9.42
	# ☐ #	27	9.52	-9.52
	# ☐ #	28	9.55	-9.55
	# ☐ #	29	9.52	-9.52
	# ☐ #	30	9.6	-9.6
	# ☐ #	31	9.55	-9.55
	# ☐ #	32	9.6	-9.6
	# ☐ #	33	9.55	-9.55
	# ☐ #	34	9.7	-9.7
Thalweg	# ☐ #	35	9.71	-9.71
	# ☐ #	36	9.67	-9.67
	# ☐ #	37	9.58	-9.58
	# ☐ #	38.9	8.86	-8.86
BFQ3	# ☐ #	40	8.12	-8.12
BFQ4!	# ☐ #	41	7.8	-7.8

FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
7.9	7.6	73.0	0.52	
-7.9	-7.6			

dimensions			
33.5	x-section area	1.3	d mean
26.7	width	27.3	wet P
1.8	d max	1.2	hyd radi
2.1	bank ht	21.3	w/d ratio
73.0	W flood prone area	2.7	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.40	shear stress ((lbs/ft sq)
0.45	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
23.8	threshold grain size (mm)

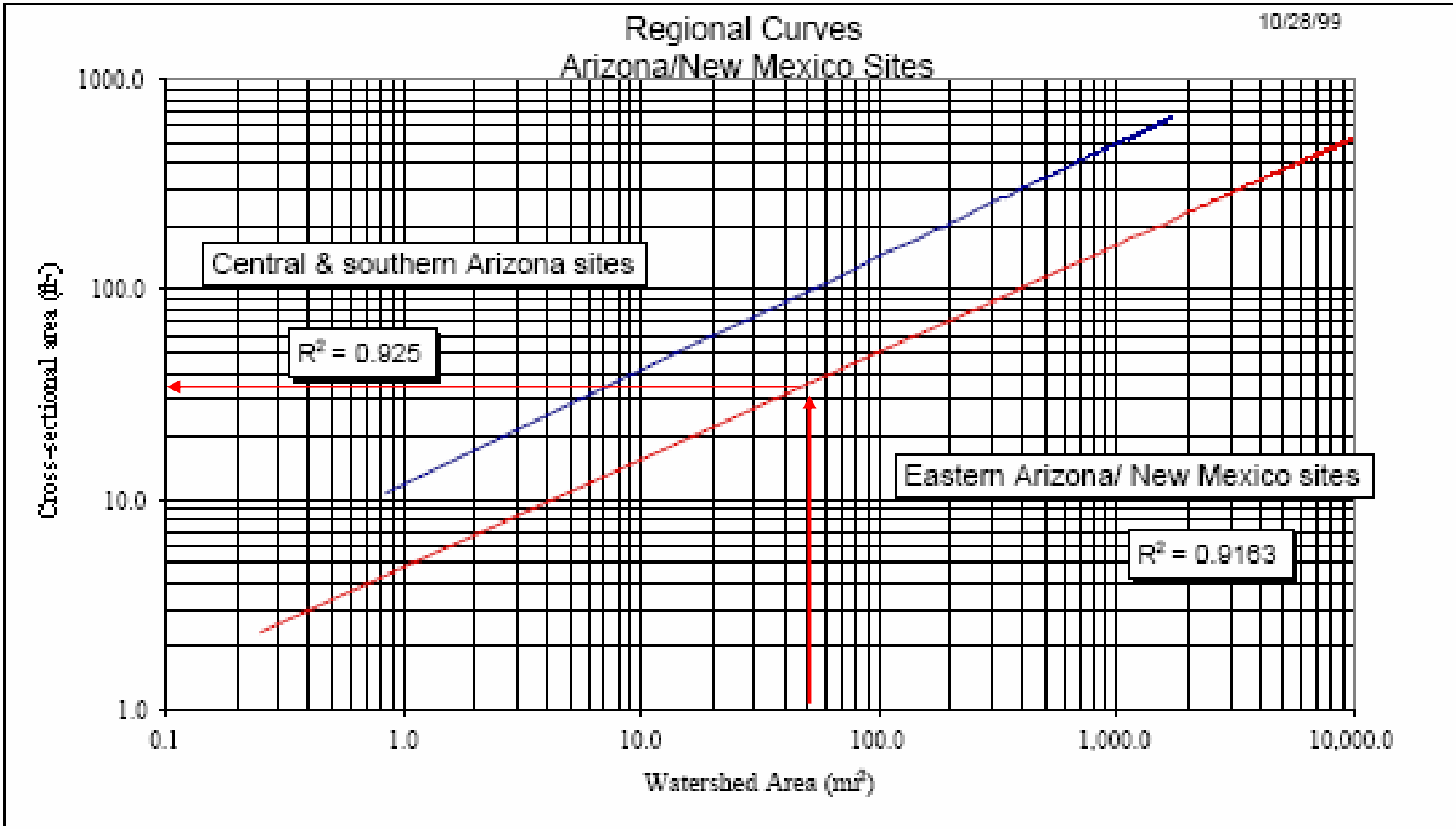
check from channel material			
61	measured D84 (mm)		
6.2	relative roughness	7.4	fric. factor
0.037	Manning's n from channel material		

Rio de La Vaca, New Mexico June 4, 2006

Regional Curves in Arizona & New Mexico

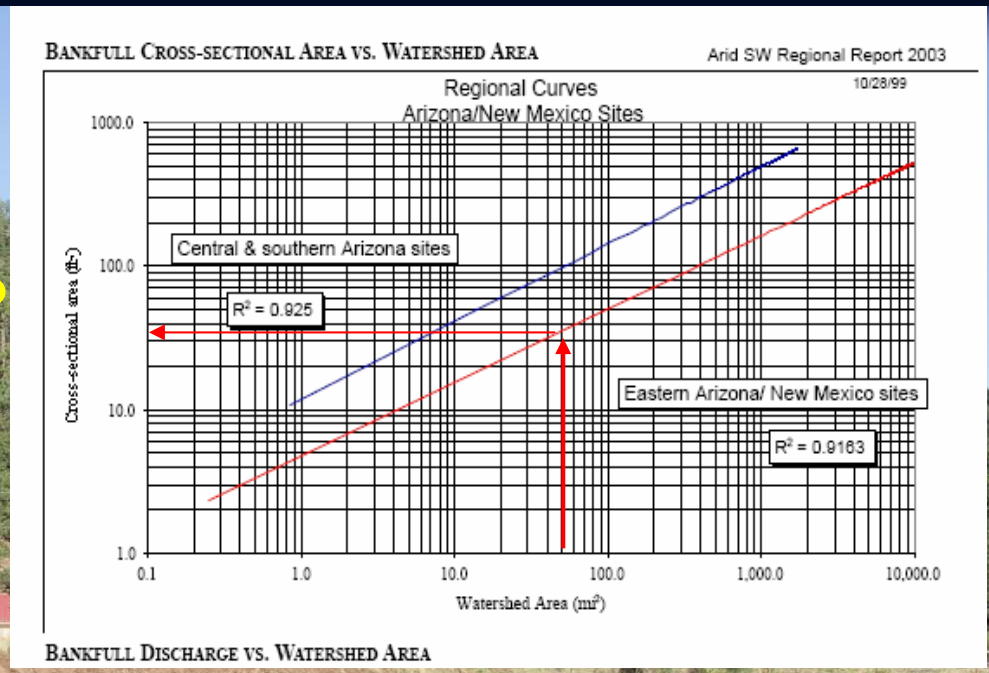
BANKFULL CROSS-SECTIONAL AREA VS. WATERSHED AREA

Arid SW Regional Report 2003

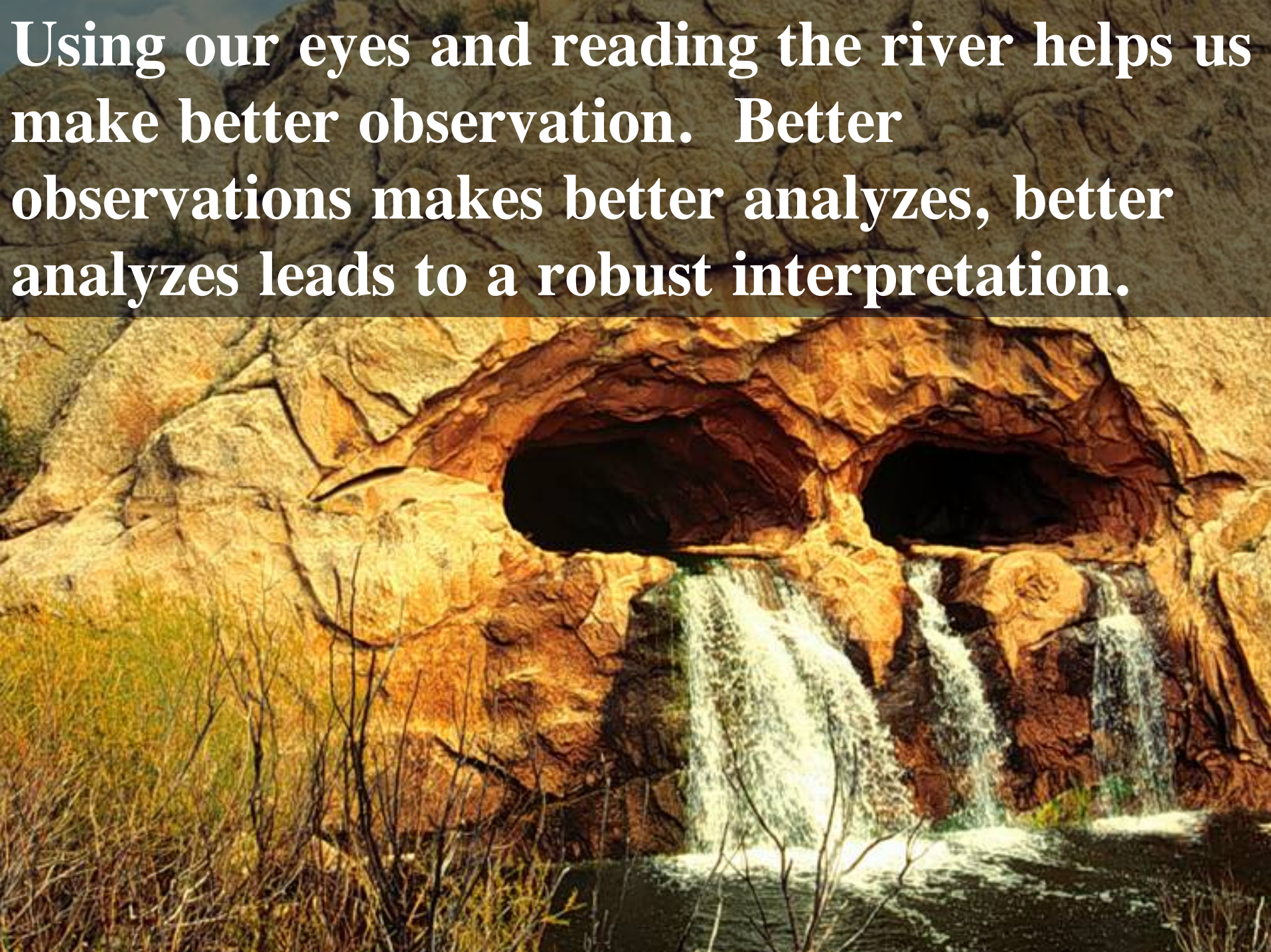


BANKFULL DISCHARGE VS. WATERSHED AREA

52 m^2 to this location
Rio de La Vaca, New Mexico



34 ft^2


Using our eyes and reading the river helps us make better observation. Better observations makes better analyzes, better analyzes leads to a robust interpretation.